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THE

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THE NOMENCLATURE OF THE OHIO GEOLOGICAL FORMATIONS.[1]

INTRODUCTION.

THE great advance in stratigraphical geology during the last fifteen years, together with the more precise and accurate description of geological formations, will lead, in most states, to a revision of the geological scale. The effect of this advance in the science was shown in New York, the classic state in American geology, when four years ago Dr. J. M. Clarke and Mr. Charles Schuchert published a revised classification of the geological formations of that state.[2] Most of the changes proposed by these distinguished authors have been accepted by working geologists and are now becoming a part of American geology.

At about the same time the writer began an investigation of the Ohio formations, but the work has not yet reached the desired completeness and accuracy; and, as will be seen by reference to the geological scale, in the case of certain formations a definite classification cannot be proposed until the information is more complete.

The advance in our knowledge of the stratigraphical geology of the state, together with the introduction of a considerable number of new names for different formations and the approaching publication of reports by the Ohio Geological Survey, led the state geologist, Professor Edward Orton, Jr., to request a revision of the geological scale of the state for these reports. In compliance with the above request, the following scale has been prepared, which in its preliminary form is now submitted for discussion. The writer will be pleased if geologists familiar with the Ohio formations will communicate to him their opinions in regard to this classification or any part of it. Such communications will be retained, duly considered, and credited in an extended discussion of this subject which the writer has in preparation.

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[1] This article has been read by Professor Edward Orton, Jr., state geologist of Ohio, and it is published with his permission.

[2] *Science*, N. S., Vol. X (December 15, 1899), pp. 874–78. The article was reprinted in the *American Geologist*, Vol. XXV (February, 1900), pp. 114–20.

GEOLOGICAL SCALE OF OHIO.

SYSTEM.	NO.	FORMATION.		THICKNESS.
QUATERNARY.	26	Alluvium. Glacial lake beds.[1] Wisconsin drift - - - - Peorian soil - - - - - - Silt or Iowan drift (?) - - Sangamon soil - - - - - Illinoian drift - - - - - -	 Chamberlin '95 Leverett '98 Chamberlin '95 Leverett '98 Leverett '97	0–550′ [2]
PERMIAN[3] (?)	25	Dunkard formation[4] - - - - (Upper Barren Coal-measures).	I. C. White '91	525′ ±
CARBONIFEROUS.	24	Waynesburg Coal, No. 11.[5] Monongahela formation - - (Upper Productive Coal-measures). Pittsburg coal, No. 8.	 H. D. Rogers '40	200–250′
	23	Conemaugh formation[6] - - - - (Lower Barren Coal-measures).	F. Platt '75	400–500′
	22	Upper Freeport coal, No. 7. Allegheny formation - - (Lower Productive Coal-measures).[7]	 H. D. Rogers '40	165–300′
	21	Pottsville formation,[8] Lesley '77	——————[9] Sharon conglomerate,[10] I. C. White '79 (?)	250′ ±
	20	Maxville limestone - - - -	Andrews '70	25′ ±
	19	Logan formation - - - - -	Andrews '70	100–150′
	18	Black Hand formation - - - - -	Hicks '78	50–500′
	17	Cuyahoga formation[11] - - - -	Newberry '70	150–300′
	16	Sunbury shale - - - - - -	Hicks '78	5–30′
	15	Berea grit - - - - - -	Newberry '70	10–135′
	14	Bedford shale[12] - - - - -	Newberry '70	50–150′

..(13)..

GEOLOGICAL SCALE OF OHIO.—*Continued.*

SYSTEM.	No.	FORMATION.	THICKNESS.
DEVONIAN.	13	*Southern and Central Ohio.* Ohio shale,[14] Andrews '70 *Northern Ohio.* Cleveland shale, Newberry '70 Chagrin formation,[15] Prosser Huron shale,[16] Newberry '70	300–2600'
	12	Olentangy shale - - - N. H. Winchell '74	20–35'
	11	Sandusky limestone[17] - - - Newberry '73	30'
	10	Columbus limestone[18] - - Newberry '73	110'
UPPER SILURIAN.	9	Monroe formation,[19] Lane '93 *Northwestern Ohio.* The formation is composed of the three following members in this part of the state : Lucus limestone,[20] Prosser Sylvania sandstone, Orton, '88 Tymochtee member (?) N. H. Winchell '73	50–600'
	8	*Northern Ohio.* " Niagara group," [21] Vanuxem '42 *Southern Ohio.* Hillsboro sandstone,[22] Orton '71 Cedarville limestone, Orton '71 Springfield limestone, Orton '71 West Union limestone, Orton '71 Osgood beds,[23] Foerste, '97 Dayton limestone.	150–350'
	7	Clinton limestone - - - - Vanuxem '42	10–50'
	6	*Northern Ohio.* Medina shales (?),[24] Vanuxem '42 *Southern Ohio.* Belfast bed,[25] Foerste '96	Wells give 50–150' Belfast 5'
...(26)..	......	....	....
LOWER SILURIAN.[27]	5	Saluda bed[28] - - - - - Foerste '02	20' ±
	......	....	....
	4	Richmond formation,[29] - - - N. H. Winchell and E. O. Ulrich '97	300' ±
	3	Lorraine formation - - - Emmons '42	300'
	2	Utica shale - - - - - - Emmons '42	250'
	1	Trenton limestone[30] - - - Vanuxem '40	130'

NOTES ON THE GEOLOGICAL SCALE OF OHIO.

1. The glacial formations of Ohio have recently been very fully described by Mr. Frank Leverett, to which account the readers interested in these deposits are referred.[1]

2. The thickness assigned to the various formations is frequently that given in the last volumes of the Geological Survey of Ohio or other late reports of Dr. Orton. Changes have been made in stating the thickness of certain formations based upon data secured by the writer or upon trustworthy statements of other authors. The thickness, however, of most of the formations differs so greatly in different sections that it is almost impossible to make general statements which will apply throughout the state. This variation is often indicated by giving the thickness as ranging *from* and *to* a certain number; as, for example, the glacial drift is given as from 0 to 550 feet in thickness.

3. In 1880 Professors William M. Fontaine and I. C. White described the flora of the Upper Barren Coal-measures of West Virginia and southwestern Pennsylvania, and stated:

> To sum up finally the evidence derived from all sources, we find ourselves irresistibly impelled to the conclusion, that the . . . . Upper Barrens of the Appalachian Coal Fields are of Permian age.[2]

The fauna of these rocks is very small and does not afford any conclusive evidence as to their age, but the flora has recently been re-examined by Dr. David White, who corroborates the earlier conclusions of Fontaine and I. C. White. Dr. David White writes:

> Recent collecting materially increases the Permian evidence, and seems to leave little room for doubt that the beds in and above the Washington limestone are referable to the Lower Rothliegende of western Europe. The data so far obtained from the lower beds of the Dunkard are, in the judgment of the writer, not yet conclusive as to Permian age.[3]

The Rothliegende is the older division of the Permian of western Europe, which is found typically in Germany. The lower Washington limestone occurs in the lower part of the Dunkard formation and at the typical locality at Washington in

[1] U. S. Geol. Surv., *Monograph XLI, 1902.*

[2] *Second Geol. Surv. Pa.*, PP., p. 119.

[3] *Science*, N. S., Vol. XVII (February 20, 1903), p. 298.

southwestern Pennsylvania, 117 feet above the top of the Waynesburg coal or base of the Dunkard formation. A number of the European geologists have accepted Permian as the age of the Dunkard formation, and Dr. Frech states that the Dunkard Creek beds and Cassville plant shale, the latter of which is the shale at the base of the Dunkard formation immediately overlying the Waynesburg coal, are the equivalent of the Kusel stage, which is the oldest formation of the Lower Rothliegende of Germany. And in another sentence is the statement that the petrographical and paleontological similarity of the Dunkard with the Rothliegende of western Europe is therefore beyond doubt.[1]

4. The formation was named the "Dunkard Creek series" on account of the fine exposures found for thirty miles along the banks and bluffs of this stream, which flows along the West Virginia-Pennsylvania line;[2] later, with Dr. White's sanction, the name was shortened to the "Dunkard formation," thus bringing it in harmony with the terms now usually selected for the names of formations.[3] On the scale below the accepted name for this formation is given in parenthesis "Upper Barren Coal-measures," the name which has generally been used for this formation in the Ohio reports. The corresponding name which has been used in the Ohio reports for the three succeeding formations is given in the same manner.

5. The top of the Waynesburg coal, or its horizon, and the base of the Pittsburg coal mark the top and bottom of the Monongahela formation.

6. Franklin Platt applied this name to the "Middle Barren Measures" and "Mahoning sandstone" in his "Column of Palæozoic formations," but failed to define it more precisely.[4] Later the name was defined and used for this formation in Maryland.[5]

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[1] *Lethaea geognostica*, Th. I; *Lethaea palaeozoica*, Bd. II, Lief. 3 (1901), p. 546.

[2] *Bull. U. S. Geol. Surv.*, No. 65, pp. 19, 20.

[3] O'HARRA, *Maryland Geol. Surv.*, *Allegany County*, 1900, pp. 86, 128; and PROSSER, JOUR. GEOL., Vol. IX (1901), p. 428.

[4] *Second Geol. Surv. of Pa.*, H, p. 8.

[5] O'HARRA, *Maryland Geol. Surv.*, *Allegany County*, 1900, pp. 86, 118; and PROSSER, JOUR. GEOL., Vol. IX (1901), p. 426.

The "Conemaugh formation" includes all the rocks between the base of the Pittsburg coal and the top of the Upper Freeport coal. On the Huntington folio of the *Geologic Atlas of the United States*, Mr. Campbell has referred between 200 and 300 feet of conglomeratic rocks succeeding the Kanawha black flint to the "Charlestone sandstone,"[1] which was named by Campbell and Mendenhall in 1896 from exposures near Charleston, W. Va.[2] and probably represents about the lower third of the Conemaugh formation. The succeeding 800 feet of shales and sandstones of the Huntington quadrangle are correlated with the "Braxton formation" by Mr. Campbell and represented as covering all that portion of southern Lawrence county, O., to the east of Ironton, which is represented on this quadrangle. This formation, as described in this folio, probably includes about the upper two-thirds of the Conemaugh and the lower part of the Monongahela formation. It was named in 1896 by Taff and Brooks from exposures in Braxton county in central West Virginia.[3]

7. Drs. Orton and I. C. White practically agreed in tracing the Lower Coal-measures or Allegheny formation from the Ohio-Pennsylvania state line across the state to the Ohio River.[4] On the Huntington folio, West Virginia-Ohio, of the *Geologic Atlas of the United States*, Mr. Campbell used the name "Kanawha formation" for the rocks considered of this general age which occur on the southern part of the sheet.[5] The formation was described by Campbell and Mendenhall in 1896;[6] but it is probably somewhat greater than the Allegheny formation, since it includes the rocks from the top of the Pottsville to the horizon of the Kanawha black flint, which is given by Campbell as 30 or 40 feet above the horizon which Dr. I. C. White considered as the top of the Allegheny formation.[7]

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[1] No. 69, p. 4, and sheets.

[2] U. S. Geol. Surv., *Seventeenth Ann. Rept.*, Part II, p. 508.

[3] *Geologic Atlas of the United States*, Buckhannon folio, No. 34, p. 2, and sheets.

[4] ORTON, *Rept. Geol. Surv. Ohio*, Vol. V, pp. 1–128, and Vol. VII, pp. 276–82; I. C. WHITE, Bull. U. S. Geol. Surv., No. 65, pp. 130–36.

[5] Folio 69, 1900, p. 4 and sheets.

[6] U. S. Geol. Surv., *Seventeenth Ann. Rept.*, Part II, p. 499.

[7] *Ibid.*, p. 4.

The name was apparently preoccupied, however, when used by Campbell and Mendenhall, for in 1877 Franklin Platt, in his classification of the rocks that would be penetrated by a well ten miles in depth near Waynesburg in southwestern Pennsylvania, proposed the name "Kenawha (as he spelled it) river system," from the river of that name in West Virginia, division *b* of which he called the "Kenawha Coal-measures."[1] The Pottsville conglomerate formed the upper part of the Kenawha river system and the Mountain limestone its base, so that the rocks were all older and below the Kanawha formation of Campbell and Mendenhall. In case it is held that Platt did not define this division with accuracy, and that the Kanawha formation of Campbell and Mendenhall ought to be accepted by prescription, then it is to be remembered that the name "Kanawha black flint" was definitely applied by Dr. I. C. White to a subdivision of the Barren Measures, or Elk River series, in 1891.[2]

In reference to the correlation of the Kanawha and Allegheny formations, it may be said that Dr. David White has studied the flora of the Kanawha formation in its typical region, and claims that the lower portion is older than the Allegheny formation;[3] while the flora of its upper part is "probably not higher than the Clarion group in the Allegheny series."[4] The horizon of the Upper Freeport coal, the top of the Allegheny formation, is indicated as between 200 and 300 feet above the Kanawha black flint.[5]

This paper has been very positively answered by Dr. I. C. White, who says:

> During the present year (1901) I have attacked the problem in question by direct tracing of the Upper Freeport coal and its associated strata from the Pennsylvania line along their eastern outcrops across to the Kanawha valley. In this I was entirely successful, and the result is a complete confirmation of my original conclusion with reference to the horizon of the Upper Freeport coal on the Great Kanawha, namely, that it is the first one below the black-flint stratum, and hence this latter member belongs near the *base of the*

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[1] *Second Geol. Surv. of Pa.*, H², pp. xxiv–xxvii.

[2] *Bull. U. S. Geol. Surv.*, No. 65, p. 98.

[3] *Bull. Geol. Soc. Amer.*, Vol. XI (1900), pp. 165–67.

[4] *Ibid.*, p. 170.

[5] *Ibid.*, pp. 173, 178.

Conemaugh formation, or just above the *top* of the Allegheny, where my studies in 1884 first placed it, instead of near the *base of the Allegheny*, to which position Dr. David White has assigned it on the basis of fossil plants[1]

Dr. I. C. White also states in this paper that in the red-shale belt of the Conemaugh formation

> occurs an important fossiliferous limestone horizon, the "green Crinoidal limestone" of the Pennsylvania series, which has been traced from central West Virginia northward to the Pennsylvania line and through southwestern Pennsylvania into Ohio [where it is known as the Ames limestone] and across that state without a break to where it re-enters West Virginia again at Huntington.[2]

And finally he states that "the Pittsburg coal is found in the summits of the hills only two miles north from Charleston," W. Va.[3]

Recently Dr. David White is reported to have said that:

> The further study of the floras indicates not merely that the middle of the formation [Kanawha] may be of Mercer age, but that beds up to within 125 feet of the "Black Flint" are clearly referable to the latter group, while the basal Allegheny time boundary is probably very much nearer the level of the Black Flint."[4]

For a further discussion of this subject, by Dr. I. C. White, especially regarding the horizon of the Kanawha black flint, see the W. Va. Geol. Surv., Vol. II, July, 1903, p. 501 and other pages.

For an explanation of the adoption of "Dunkard," "Monongahela," "Conemaugh," and "Allegheny" as formation names in Ohio, see a former paper by the present writer.[5]

Dr. I. C. White prefers to consider these terranes as series, and writes me as follows:

> I think the term "series" better describes the different divisions of the Carboniferous system, like Dunkard, Monongahela, Conemaugh, Allegheny, Pottsville, etc., and have so used it in my coal volume.[6]

8. So far as the writer is aware, the name "Pottsville conglomerate" did not first appear over the name of Professor

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[1] *Ibid.*, Vol. XIII (1902), p. 122. [2] *Ibid.*, p. 123. [3] *Ibid.*, p. 124.

[4] MENDENHALL's Report of the 144th Meeting of the Geological Society of Washington, *Science*, N. S., Vol. XVII (June 12, 1903), p. 942.

[5] *Am. Jour. Sci.*, 4th ser., Vol. XI (1901), pp. 191–200 and in particular p. 199.

[6] Letter of April 2, 1903.

Lesley, but on its first publication in 1877 it is distinctly stated by both Ashburner[1] and Franklin Platt[2] that it is "proposed by the present State Geologist of Pennsylvania," and the following year Professor Stevenson mentioned Professor Lesley's name in crediting the authorship of the formation.[3] In the Ohio reports this formation has generally been termed the "Conglomerate group," although Dr. I. C. White as early as 1881 applied the name "Pottsville conglomerate" to the continuation of these rocks across the state line in Crawford county, Pennsylvania. Certain geologists, however, have thought that these rocks of Ohio and western Pennsylvania represented a longer time interval than the typical Pottsville conglomerate of eastern Pennsylvania, and hence it has appeared doubtful whether the name "Pottsville" should be applied to the Ohio formation. At the base of the formation in northern Ohio is a conglomerate or coarse grained sandstone which has generally been called the "Sharon conglomerate," and is perhaps equivalent to the Olean conglomerate of southwestern New York. Regarding the stratigraphic position of this latter conglomerate Dr. J. M. Clarke has written me as follows:

> It may interest you to know with regard to the Carboniferous horizons that . . . . Messrs. David White and Campbell have been over the field in Cattaraugus county, and they have convinced themselves that there is no longer any question of the Pottsville age of the Olean. This determination seems to be based largely on the evidence of fossil plants.[4]

This conclusion agrees with the statement of Mr. M. R. Campbell, apparently based upon the investigations of Dr. David White, regarding the age of the Sharon conglomerate of western Pennsylvania. Mr. Campbell says:

> From the evidence afforded by fossil plants, Mr. White proves conclusively that about the beginning of the Pottsville epoch an uplift occurred, which affected much of the Mississippi Valley. A large land area was formed that extended as far east as the Broad Top Basin and the Northern Anthracite field. This land area persisted until at least 600 feet of Pottsville sediments were deposited in the southern Anthracite basin. A subsidence then occurred

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[1] *Proc. Amer. Phil. Soc.*, Vol. XVI, p. 533.

[2] *Second Geol. Surv. Pa.*, H^2, p. xxvi.

[3] *Ibid.*, K^3, 1878, p. 12.

[4] Letter of April 30, 1903.

in the western part of the state, which allowed the Sharon conglomerate and its associated coal group to be deposited.[1]

Pottsville sandstone is used by Mr. Campbell as the name of the formation in the Masontown-Uniontown folio in southwestern Pennsylvania, and it now appears that there is sufficient evidence to warrant the application of the term Pottsville to the Ohio formation, as has been done by the United States Geological Survey.[2]

9. In the later reports of the Ohio Survey the following main divisions of the "Conglomerate group" were given as succeeding the Sharon conglomerate in the following order: Sharon coal, Lower and Upper Massillon sandstones, Lower and Upper Mercer groups, and Homewood sandstone, the last one named forming its upper part;[3] while in Pennsylvania, in Crawford county, along the Ohio line, Dr. I. C. White gave the Pottsville as composed in ascending order of the following divisions: Sharon, Conoquenessing, Mercer group, and Homewood sandstone. The Sharon Division consisted in ascending order of a conglomerate, Lower shales, Coal and Upper iron shales, and the Conoquenessing division of the Lower and Upper sandstones separated by the Quakertown beds.[4] Finally, in the Charleston, W. Va. folio, which is the next quadrangle east of the Huntington, Mr. Campbell has used the name "Sewell formation" for the rocks of Pottsville age shown in that area;[5] but it is not known how much of the "Conglomerate group" of Ohio is included in this formation. It was named in 1896 by Campbell and Mendenhall from the outcrops near Sewell on the New River in southern West Virginia.[6]

In northern and central Ohio it appears probable that the Pottsville formation will be divided into at least two members. The lower one is the conglomerate or coarse sandstone, generally termed the "Sharon conglomerate," which is a conspicuous lithologic division. At present we are not prepared to propose a classification for the remaining part of the formation.

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[1] *Geologic Atlas U. S.*, Masontown-Uniontown folio, No. 82, 1902, p. 7.

[2] *Twenty-second Ann. Rept.*, Part III (1902), Pl. XII.

[3] *Rept. Geol. Surv. Ohio*, Vol. VII (1895), p. 36.

[4] *Second Geol. Surv. Pa.*, Q^4, 1881, pp. 55 ff.

[5] *Geologic Atlas of the United States*, Folio 72, 1901, p. 4, and sheets.

[6] U. S. Geol. Surv., *Seventeenth Ann. Rept.*, Part II, p. 494.

10. In the later reports of the Ohio Survey this division is usually called the "Sharon conglomerate." Professor Lesley used the name "*Sharon conglomerate* (Ohio conglomerate)" in the list of geological divisions for Lawrence county, Pa.,[1] and on p. xxxiv he states that the Sharon conglomerate "is undoubtedly part (or the whole) of the *Ohio conglomerate*." Also on p. 296 is a brief description by Dr. I. C. White of the Sharon conglomerate as exposed near the town of that name. Of the two names used by Professor Lesley, "Ohio" was preoccupied, since Andrews used it in 1870 for the Ohio shale; and it is a question whether Sharon was available, since Professor H. D. Rogers in 1858 proposed the name "Sharon group" for the Sharon coal and associated rocks overlying this conglomerate, but apparently *not* including it,[2] and in 1877 Professor Stevenson followed Rogers in describing the Sharon coal group of western Pennsylvania.[3]

The "Olean conglomerate" was formally named and described by Ashburner in 1880 in his description of the geology of McKean county.[4] The above statement is corroborated by Professor Lesley, for he has stated that "The Olean conglomerate received its name during the survey of McKean county from the magnificent fragment of it at the rock city north of the state line, west of the town of Olean [N. Y.]."[5] The above, however, was not the first usage of the name "Olean" for this conglomerate, for Professor Lesley himself in 1875 used the term "Olean conglomerate (Garland)" in referring to this formation in northwestern Pennsylvania.[6] Later in the same report Mr. Carll used the name "Garland conglomerate" for the rocks capping the hills in the vicinity of Garland, Warren county, Pa. (p. 45). I cannot say positively that the names "Olean" and "Garland conglomerate" made their initial appearance in geological literature in the above-quoted instances. In 1875, however, under the direction of Mr. Carll, a spirit-level line was run across northwestern Pennsylvania "for the purpose of connectedly tracing the several *outcrops of Garland conglomerate*, that they might thus be identified with cotemporaneous rocks in the state of New York on the one side and in the state of Ohio on the other."[1] As a result of this work, Mr. Carll stated that the Garland conglomerate "is apparently identical with the *Olean* conglomerate in McKean county; with the *Sharon conglomerate* in Mercer county; [and] with the *Ohio conglomerate* in Ohio,"[2] and the chapter is headed "The Garland (Olean or Sharon) Conglomerate."[3] In Carll's succeeding report he abandoned the use of "Garland conglomerate" in favor of "Olean conglomerate," and in explanation said:

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[1] *Second Geol. Surv. Pa.*, Q ^{2}, 1879 (?), Preface, p. xxix.

[2] *Geol. of Pa.*, Vol. II, p. 489.

[3] *Second Geol. Surv. Pa.*, K ^{2}, p. 103.

[4] *Ibid.*, p. 56; and see "General Vertical Section of the Rocks of McKean County," on p. 43.

[5] *Ibid.*, "A Summary Description of the Geology of Pennsylvania," Vol. III, Part I, 1895, p. 1873.

[6] *Ibid.*, I, p. 38, footnote.

> In Report I, I^2, I^3, I have used the term *Garland conglomerate.* It is now demonstrated that my *Garland conglomerate* is the *Olean conglomerate* of Mr. Ashburner's report on McKean county, and I shall therefore use the latter term in this report.[4]

Professor H. S. Williams apparently considered the "Sharon conglomerate" in the Cuyahoga and Painesville sections as equivalent to the "Olean conglomerate," for in those sections it is lettered H, and in the paper is the statement that "H is the conglomerate (Olean and equivalent)."[5]

Finally, on the *Geologic Map of New York*, by Frederick J. H. Merrill, published in 1901 [1902], the "Olean conglomerate" appears as the name of this Carboniferous formation in southwestern New York. Regarding the identity of these two conglomerates, Dr. J. M. Clarke has written me as follows:

> I have recently come into possession of an elaborate compilation of all the well sections in the region of McDonald, Pennsylvania, prepared by Mr. F.

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[1] *Ibid.*, I^3, 1880, p. 11.

[2] *Ibid.*, p. 13.

[3] *Ibid.*, p. 11.

[4] *Ibid.*, I^4, 1883, p. 185, footnote.

[5] *Proc. A. A. A. S.*, Vol. XXXIV (1886), p. 225; and see "Meridional Sections of the Upper Devonian Deposits of New York, Pennsylvania, and Ohio."

H. Oliphant, wherein the Sharon conglomerate is made identical with the Olean.[1]

Dr. I. C. White would retain the name "Sharon" for this conglomerate, and has written me to this effect. He says:

> I do not think the use of "Sharon" for the *conglomerate* of that name is forbidden because it had previously been given to a *coal* bed, since the things are so unlike, ... I think "Sharon" conglomerate which applies only to a particular bed of the "Pottsville" series, should stand, and not be replaced by "Olean," since the term "Sharon" is older as applied to the stratum in question.[2]

Regarding the age of the Olean and the question of its correlation with the Sharon conglomerate Dr. David White has written as follows:

> The Olean is shown to be Pottsville. It contains sufficient Upper Carboniferous plants to prove it to be Pennsylvanian; but not enough to strictly define its age beyond Upper Pottsville. . . . . The correlation of Sharon and Olean is a working assumption based in part on circumstantial evidence, both formations being found in the same relation, beneath the thin sections of Pottsville, on the eroded Lower Carboniferous. I have no conclusive proof that they are equal and represent the same formation. And, since over part of the way between Sharon and Olean the Conoquenessing seems to rest directly on the Pocono, I personally favor the use of Sharon, in conformity with Dr. I. C. White's usage, until satisfactory proof of the identity of Olean and Sharon may be established.[3]

Therefore, since there is yet some doubt regarding the identity of the Olean and Sharon conglomerates, the latter name is retained for the present for this member of the Pottsville formation in Ohio.

11. Possibly later studies may decide that for eastern Ohio it will be better to drop the name "Cuyahoga formation" and use the classification of western Pennsylvania for the rocks between the top of the Berea grit and the base of the Sharon conglomerate, which in ascending order are Orangeville shale, Sharpsville sandstone, Meadville shales, and Shenango sandstone, all named and described by Dr. I. C. White in 1880, with the exception of the Meadville shales, which was published in 1881. Professor H. P. Cushing, however, writes me as follows regarding this matter:

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[1] Letter of March 23, 1903. [2] Letter of April 2, 1903. [3] Letter of June 10, 1903.

> I do not believe that the Pennsylvania subdivisions can be made out west of Ashtabula and Trumbull, or even that they are well marked on the highland west of the Grand River, in those counties. Here in Cuyahoga the shales between the Berea and the conglomerate show only a twofold lithological division, to the best of my knowledge, and the boundary occurs about half way up. The lower half consists of soft, blue-black, clay shales with a few local flags, especially toward the base. On top of these comes a flaggy horizon, at what I take to be the Sharpsville level, followed by alternating shales and concretionary layers, with some flags. . . . . The basal shales are sparingly fossiliferous, a big *Orbiculoidea* most abundant, and impressing a layman as being a Sunbury fauna in depauperate condition. The flags and following shales hold a numerous fauna, pyritized and badly preserved in the flags, excellently preserved in the concretions, which form definite bands.[1]

Again in southern Ohio, in the Ohio River section, below and above Portsmouth, succeeding the top of the Sunbury shale, which is a very conspicuously marked horizon, it is a matter of some difficulty to divide the remaining Waverly rocks into the formations which are so clearly marked lithologically in central Ohio.

12. The formations from Nos. 14 to 19, inclusive, form the Waverly series. For a revision of the classification of this series see a paper by Prosser in JOURNAL OF GEOLOGY, Vol. IX (1901), pp. 205–32; and for an extended discussion of the Sunbury shale, *ibid.*, Vol. X (1902), pp. 262–313.

13. The line of division between the Carboniferous and Devonian systems is in doubt, as indicated by the dotted line on the chart. In recent years it has generally been drawn at the base of the Bedford shale, but Professor C. L. Herrick has indicated the line as high as the lower part of the Black Hand formation, or perhaps even higher.[2] Dr. I. C. White writes me as follows concerning this point:

> The *red Bedford shale* is undoubtedly of Catskill age, as is also the Berea sandstone and its overlying shale (I think), since it becomes *red* in passing eastward. If you mean to class the Catskill as *Carboniferous*, then your division is correctly drawn, but if you think the Catskill is Devonian, then the Carboniferous line should be drawn at the base of the Cuyahoga. I am non-committal on the general question as to whether we should include

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[1] Letter of April 2, 1903.

[2] *Bull. Den. Univ.*, Vol. IV (1888), pp. 100, 106.

the Catskill in the Carboniferous or not, but the *red Bedford* and the overlying Berea with its shale above (red at the east) are certainly of Catskill age.[1]

14. David Dale Owen in giving a summary of the geology of Indiana, after stating that the soft freestone knobs of that state were equivalent to the Waverly rock of Ohio, said: "The black slate in the base of these knobs is the equivalent of the Scioto slates and shales."[2] In the above reference Dr. Owen undoubtedly referred to the shales which were later named the Ohio by Andrews; but it is thought that this casual use of the term "Scioto slates and shales" ought not to replace the definite one of Andrews, which is now a well-known name in geological literature.

In 1877 Professor Shaler, evidently unaware that Professor Andrews had named the Black shale of southern Ohio the "Ohio black slate," proposed as a new name for this formation "Ohio shale."[3]

In northern Ohio, equivalent to the "Ohio shale" of southern and central Ohio, are three formations, the lower and upper ones composed mainly of black shale and called the "Huron and Cleveland shales," separated by a mass of grayish shales, and thin sandstones now called the Chagrin formation.

15. This formation was named the "Erie shale" by Newberry in 1870, but it was preoccupied. Vanuxem in 1842 named one of the divisions of the New York system, the "Erie," which was composed of the formations ranging from the Marcellus shale to the Chemung inclusive; while Logan in 1863 named one of the Quaternary formations of Ontario the "Erie clay."[4] Finally, the name "Girard" shale, applied by Dr. I. C. White in 1881 to a mass of Devonian shales in Erie county in northwestern Pennsylvania,[5] is only equivalent to a portion of Newberry's Erie shale.

The name *Chagrin formation* is, therefore, proposed for this mass of argillaceous and arenaceous shales and calcareous layers on account of the excellent exposures on the banks of this river extending from Willoughby to the south of Pleasant valley. With perhaps the exception of the cliffs on the shore of Lake Erie, there are probably no finer outcrops of the formation to be found than those forming the steep banks of the Chagrin River. One and one-half miles south of Willoughby is a cliff nearly a hundred feet high, and a magnificent one more than a hundred feet high occurs a mile below Pleasant valley, about four miles up the river southeast of Willoughby.

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[1] Letter of April 2, 1903.

[2] *Cont. Geol. Rec. of the State of Indiana*, 1838, Part II, 1859, p. 59.

[3] Geol. Surv. Ky., *Rept. Prog.*, Vol. III, N. S., p. 169.

[4] Geol. Surv. Canada, *Rept. Prog. from Com. to 1863*, pp. 896, 897.

[5] *Second Geol. Surv. Pa.*, Q^4, pp. 117, 118.

16. The term "Huron shale" was proposed by Dr. Newberry in 1870 for "the great mass of black, bituminous shale, designated by the former Geological Board as the 'Black Slate.'"[1] Its outcrop was described as forming "a belt from ten to twenty miles in width, reaching from the Lake shore [Erie] at the mouth of the Huron River, almost directly south to the mouth of the Scioto." Its outcrop on the shore of Lake Erie was given as extending from east of Sandusky to Avon Point. The higher black shale outcropping near Cleveland was named the "Cleveland shale," which was separated from the lower black shale or Huron by the Erie shale. It is generally supposed that Newberry's "Huron shale" in northern Ohio, although represented on the *Preliminary Geological Map of Ohio*, accompanying this report, as extending across the state from Lake Erie to the Ohio River and in the southern part apparently comprising all of the black shale which Andrews, later in the same report, named the "Ohio black slate," represented only the lower mass of black shale which occurs in the northern part of the state. It was not until much later that it was known that the top of the Ohio shale in southern Ohio corresponds with the top of the Cleveland shale and that Andrews's "Ohio Shale" is equivalent to the Huron, Erie, and Cleveland shales of Dr. Newberry in northern Ohio.

In 1861 Professor Alexander Winchell gave the name "Huron group" to a division of the Michigan rocks, which included all the deposits between the top of his Hamilton group and the base of a conglomerate overlying the Pt. aux Barques gritstones.[1] This comprised a much greater stratigraphic range than the Huron shales of Newberry, since on the Ohio scale it represents approximately all the rocks from the base of the Huron shales nearly to the top of the Cuyahoga, and perhaps into the Black Hand formation.[2]

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[1] Geol. Surv. Ohio, *Rept. Progress in 1869*, Part I, p. 18.

Newberry, however, in his first description of the Huron shales, did not refer to the Huron group of Winchell, although together they had examined the rocks about Cleveland[3]; but in a later report he stated that in Michigan they form "the lower part of Professor Winchell's *Huron group*." And he furthermore said that the two members of Winchell's Huron group "having nothing in common either in lithological characters or fossils, we have in Ohio separated them; giving the name *Erie* shale to the upper portion, retaining the name of *Huron* for the lower."[4] This plan, however, does not appear to have been a happy solution of the question, and it was, therefore, submitted to the Committee on Geologic names of the U. S. Geological Survey, and the chairman, Mr. Bailey Willis, has sent me the following communication:

> *Huron group* or *Huron shale* was brought before the committee through a letter from Professor Prosser of May 28, 1903, the question being whether a formation . . . . the *Huron shale* . . . . may bear the same name as a group to which it belongs; it was the sense of the committee that such use of terms in duplication was contrary to the regulations of the Geological Survey, and that, as the group had been named in 1861 and the shale not until 1869 [1870], the term *Huron* should be applied to the *group*.[5]

In 1893 A. C. Lane named the shales forming the lower part of Winchell's Huron group the "St. Clair," which were included between the Traverse group and the Richmondville or Berea sandstone of the Michigan formations.[6] Dr. Lane has written me that: "I do not now think that [the Richmondville] is the Berea but a stray sandstone, somewhat higher up."[1] In the Ohio formations the "St. Clair shale" represents approximately the rocks from the top of the Olentangy shale to the base of the Berea grit, and therefore is neither synonymous with Newberry's Huron shale nor with Andrew's Ohio shale, since the equivalent of the Bedford is included in the St. Clair shale. The name "St. Clair," however, was preoccupied when used by Lane, because Dr. Penrose, Jr., in 1891 gave it to a Silurian limestone in northern Arkansas,[2] and therefore Lane has renamed the St. Clair the "Antrim shales."[3] In 1874 Mr. William W. Borden named the black shale in southern Indiana the "New Albany black slate;"[4] but it is considered that this represents more nearly the thinned westward extension of the Ohio shale, after crossing Kentucky, than Newberry's Huron shale. Outcrops of the New Albany shale have been described by Dr. Kindle in the Wabash River region of northern Indiana to the westward of Logansport.[5]

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[1] Geol. Surv. Mich., *First Bien. Rept. Prog.*, 1861, pp. 71, 139.

[2] See LANE, *Geol. Surv. Mich.*, Vol. VII, Part II (1900), Pl. I.

[3] Geol. Surv. Mich., *First Bien. Rept. Prog.*, 1861, p. 78.

[4] *Rept. Geol. Surv. Ohio*, Vol. I, Part I (1873), p. 70.

[5] Letter of June 13, 1903.

[6] Mich. Geol. Surv., *Rept. State Board for 1891 and 1892*, p. 66.

It does not appear to the writer that the term "Huron shale" of Newberry can stand as the name of this formation, for, as Dr. Orton has said in discussing the name, "it would have served the interest of geological classification much better to have replaced the term altogether than to have restricted it to a small fraction of what it was originally made to cover."[6] Neither does it appear that either of the other names is applicable for this shale. On a recent trip to the Huron River, however, the writer found that the shale banks above and below Monroeville were composed mainly of an upper black shale, apparently the Cleveland, below which are blue and olive shales alternating with black ones; this lower division probably representing part of the Chagrin formation. Apparently only the upper part, if any, of the Huron shale is shown in the gorge of this river, which was supposed to afford excellent exposures of this shale, while to the west of the Huron River the streams have not cut deep gorges and the older rocks are poorly shown. It is evident that further field work in northern Ohio is necessary before a satisfactory name and classification can be proposed for these shales; therefore, for the present, the name "Huron shale" is retained.

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[1] Letter of April 20, 1903.

[2] Geol. Surv. Ark., *Ann. Rept.*, 1890, Vol. I (July, 1891), p. 124.

[3] *Michigan Miner*, September 1, 1901, p. 9; *Rept. State Board Geol. Surv. Mich. for 1901, 1902*, pp. 66, 209, footnote 48; and RUSSELL in U. S. Geol. Surv., *Twenty-second Ann. Rept.*, Part III, 1902, Pl. XLIV, p. 668.

[4] Geol. Surv. Ind., *Fifth Ann. Rept.*, p. 158.

[5] Ind. Dept. Geol. and Nat. Res., *Twenty-fifth Ann. Rept.*, 1901, pp. 562–65.

[6] *Rept. Geol. Surv. Ohio*, Vol. VI (1888), p. 24.

The present year Professor T. C. Hopkins has applied the name "Huron limestone" to a formation in Indiana.[1]

17. The local names of "Sandusky" and "Columbus limestones" are used for the Devonian limestones instead of Onondaga (Corniferous) of the New York classification, because it is probable that the Sandusky limestone ought to be correlated with rocks of later age than the Onondaga limestone, viz., the lower part of the Erian series of New York. Confirmation of this idea is found in a paper by the late Edward Claypole which has just been published.[2]

"Sandusky" is used instead of "Delaware limestone" because both names evidently refer to the same formation, and "Sandusky" antedated "Delaware limestone" by five years. Dr. Newberry published the name "Sandusky limestone" in 1873, and stated that it "is the rock quarried at Sandusky and Delaware,"[3] and the "Delaware limestone" was apparently named by Dr. Orton in 1878 on account of "its occurrence at Delaware, and the extensive use made of it at that point."[4]

18. Mather in 1859 in a "Concise Geological Section of the Rocks Perforated by the State House Artesian Well, at Columbus," used the name "Columbus limestone" for No. 3 of the section which was given as 138½ feet in thickness, the top of which was 138 feet below the surface and covered by 15 feet of "slate" above which was 123 feet of drift.[5] The slate and Columbus limestone are again mentioned on p. 11, where he stated that they "approach in character, and may be equivalents

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[1] *Bull. Geol. Soc. Amer.*, Vol. XIII (February, 1903), p. 519.

[2] *Am. Geol.*, Vol. XXXII (July, 1903) p. 35.

[3] *Rept. Geol. Surv. Ohio*, Vol. I, Part I, p. 143.

[4] *Ibid.*, Vol. III, p. 606.

[5] *Report on the State House Artesian Well at Columbus, Ohio*, p. 6.

to the Marcellus shales, and Corniferous limestones of the New York Geological Reports." It is evident that No. 3 of Mather's section included both the Sandusky and Columbus limestones of Dr. Newberry's later classification, as Newberry stated in his section of the "State House Well," where he called No. 3 the "Corniferous limestone,[1] and which later he divided into the Sandusky and Columbus limestones.[2]

Mather's article was simply a report to the state house commissioners, and the terrane is very imperfectly defined. Since it has never been recognized in geological literature, while the Columbus limestone of Newberry is a well-known formation, it is not considered necessary to recognize Mather's name, and therefore Newberry's name of "Columbus limestone" is retained for this formation.

19. In the Ohio reports this mass of limestone, with some included beds of gypsum and sandstone, has frequently been termed "the Lower Helderberg or Waterlime formation."[3] The Lower Helderberg, however, represents now the Helderbergian series of the New York classification, while the Waterlime belongs in the next older series, the Cayugan. There are in New York, however, according to Mr. Schuchert, two divisions of the Waterlime — the lower, named the Bertie, and the upper, the Rondout, which are separated by the Cobleskill (Coralline) limestone.[4]

The correlation of the Ohio formation with those of New York is indefinite, and it appears advisable to adopt the name applied by Dr. Lane to these rocks in southeastern Michigan. The name "Monroe beds" first appeared in a "Geological Column" prepared by Dr. Lane and incorporated in a report of Dr. Wadsworth published in 1893.[5] In this publication the formation was not defined; but in 1895 it was fully described by Dr. Lane and shown to include all the rocks between the Niagara and Dundee limestones of Michigan.[1] In 1894, however, Mr. Darton named and described the Monroe shales, a Devonian formation of southeastern New York,[2] and on this account there was some uncertainty whether the Michigan name would be retained or not. The question was submitted to Mr. Bailey Willis, chairman of the Committee on Geologic Names of the U. S. Geological Survey, who has sent me the following answer :

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[1] *Rept. Geol. Surv. Ohio*, Vol. I, Part I (1873), p. 114.

[2] *Ibid.*, p. 143.

[3] See Vol. VII, pp. 4, 14.

[4] *Am. Geol.*, Vol. XXXI (March, 1903), pp. 160, footnote, and 169–78.

[5] *Rept. State Board Geol. Surv. for 1891 and 1892*, p. 66. Dr. Wadsworth states in a letter to Dr. Lane that "the late winter or early spring of 1893 was the date of publication."

> The Committee on Geologic Names on May 12 took action on the validity of the term *Monroe* in several publications of 1891, 1892 [1893], and 1895, as the name of a group of rocks distinguished in southern Michigan, as against the standing of the name published in 1894 for a shale formation in southeastern New York.
>
> The committee recommended that the *Monroe group* of southern Michigan should retain the name, and this action has been approved for official publications of the Geological Survey.
>
> The conclusion was reached on the ground that priority and prescription, or established usage, are combined in the Michigan application of the term in such a way as to make its continued use more desirable than that of Monroe shale in New York; but the case was not considered one in which priority was so definitely obvious as to justify the conclusion on the ground of the publication of 1891–2 [1893] only, since in that publication the definition was inadequate.[3]

In 1898 Professor Grabau proposed the name "Greenfield limestone" for the Ohio Waterlime, from the town of that name in the northeastern corner of Highland county, in southern Ohio, where the limestone is well shown and extensively quarried.[4] This is certainly an appropriate name for the formation in central and southern Ohio, which will be available in case further study shows that "Monroe" is not a suitable name for the Waterlime in this section of the state.

It is to be remembered, however, that Dr. Orton published the name "Greenfield Stone" in 1871 in a chart of the "Geological Series of Highland County;"[5] but did not use it as a formation name, since he described it under the name of "Helderberg limestone."[6]

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[1] *Geol. Surv. Mich.*, Vol. V, Part II, pp. 26–8.

[2] *Bull. Geol. Soc. Amer.*, Vol. V (March, 1894), p. 374.

[3] Letter of May 18, 1903.

[4] *Science*, N. S., Vol. VIII, p. 800.

[5] Geol. Surv. Ohio, *Rept. Prog. in 1870*.

[6] *Ibid.*, pp. 287–94.

20. The Monroe formation, however, in northwestern Ohio concontains a light-colored, very quartzose rock, which in 1888 was named the "Sylvania sandstone" by Dr. Orton,[1] from the exposure in a quarry about four miles west of Sylvania village, in Sylvania township, Lucas county. The stratum was first described by Mr. G. K. Gilbert in 1873, who referred it to the "Corniferous group" with a thickness of 20 feet,[2] although on the accompanying geological map of Lucus county it is apparently the division termed the Oriskany sandstone, and represented as crossing the county from the Michigan state line to the Maumee River on the south. The same terrane was represented in Wood county, south of the Maumee River,[3] and perhaps in some of the other counties of northwestern Ohio. The sandstone thickens as followed to the northeastward in Michigan, and Mr. Sherzer gives it as 50 feet in thickness in Exeter township, Monroe county, the one immediately north of Lucas county, Ohio ; while still farther north it is given as ranging from 95 to 130 feet in thickness.[4] On Mr. Sherzer's geological map of Monroe county the "Monroe beds" are represented in five divisions, and the only one to which a geographic designation is given is the Sylvania sandstone. The dolomitic limestones below the Sylvania sandstone are separated by an oölitic bed, which is given as about 100 feet below the sandstone and from 20 inches to 2 feet in thickness.[5]

It appears to the writer that the Monroe formation of northwestern Ohio may probably be divided into at least three members. For the upper one the name *Lucas limestone* is proposed, from Lucas county, which it crosses from north to south. It may be studied at the typical locality in Sylvania township, described by Mr. Gilbert in 1873, where are the extensive quarries of the Toledo Stone and Glass Sand Company and the place now named Silica, or in the banks of the Maumee River bordering Providence township. It includes all the rocks between the top of the Sylvania sandstone and the base of the Columbus limestone, or the base of the formation which Dr. Lane in Michigan has named the "Dundee limestone.[1] The middle member is the Sylvania sandstone of Dr. Orton which was called the "Oriskany sandstone" on the geological maps of Lucas and Wood counties. The rocks below the sandstone are shown at various localities on both banks of the Maumee River from the vicinity of the Providence-Waterville township line, Lucas county, to Maumee. Provisionally this member is termed the "Tymochtee," a name given in 1873 by Professor N. H. Winchell to the thin-bedded Waterlime exposed on the banks of this creek in Crawford township, Wyandot county.[2] The limits of the "Tymochtee slate" were not definitely fixed by Winchell, and further investigation may render it inadvisable to retain this name. Professor Winchell, however, used it for the thin-bedded Waterlime in several of the northwestern counties, and compared the beds of this character in Wood county with it.[3]

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[1] *Rept. Geol. Surv. Ohio,* Vol. VI, p. 18.

[2] *Ibid.,* Vol. I, Part I, p. 576.

[3] *Ibid.,* Vol. II, Part I (1874), op. p. 368.

[4] *Geol. Surv. Mich.,* Vol. VII, Part I (1900), p. 54.

[5] *Ibid.,* p. 61.

21. In the New York classification this division has been abandoned, and the two older ones of "Rochester shale" and "Lockport limestone" accepted as formations; the former representing the lower, and the latter the upper part of the old "Niagara group." At present we are unable to correlate precisely the Ohio rocks with these two eastern formations; therefore the more general term of "Niagara," which has been used for this mass of rocks in Ohio, is retained for the time being.

22. The following subdivisions of the "Niagara group" have been recognized and defined in southwestern Ohio; but whether these shall be considered as formations or subformations, or part of them be grouped together to form new formations, we are not prepared to state at present. It does not appear probable that all of these divisions can be recognized in northern Ohio.

23. Dr. Aug. F. Foerste has stated that the Niagara shale of the Ohio reports "evidently corresponds stratigraphically to the

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[1] Mich. Geol. Surv., *Rept. State Board for 1891 and 1892* (1893), p. 66; *Geol. Surv. Mich.*, Vol. V, Part II (1895), p. 25; and SHERZER, *ibid.*, Vol. VII, Part I (1900), p. 35.

[2] *Rept. Geol. Surv. Ohio*, Vol. I, Part I, p. 633.

[3] *Ibid.*, Vol. II, Part I, p. 375.

Osgood beds of Indiana;" and apparently refers the Dayton limestone, Orton 1870, which occurs at the base of the shale, to the same division.[1] He also stated that "the West Union cliff may correspond to the limestone courses in the upper part of the Osgood beds in Indiana and western Kentucky, but it has so far not been sufficiently investigated to admit of correlation."(2)

24. The Canadian Survey has shown that the Medina formation may be traced by surface outcrops from Niagara River across Ontario and along the western shore of Georgian Bay.[3] Later the red rocks penetrated in deep wells in southern Ontario,[4] the Lower Peninsula of Michigan,[5] and Ohio[6] have been referred to the Medina formation. Dr. Lane, however, stated that in Michigan the Medina shale, "both lithologically and in the driller's records, is quite as likely to go with those below it. It is really a transition bed."[7] There is evidently uncertainty regarding the age of the red shales penetrated in the oil and gas wells of northwestern Ohio; but, in the absence of positive knowledge, they are left provisionally in the Upper Silurian and called Medina with a query.

25. There is a question whether the Belfast bed is of sufficient importance to be given the rank of a formation.

26. At present whether the line of separation between the Upper and Lower Silurian should be drawn at the top or bottom of the Belfast bed is a matter of uncertainty. Dr. Foerste states: "I am not certain as to the age of the Belfast bed myself;" and he also says that "it is the only bed which may be Lower Silurian and which may be of Medina age."[8] And in an earlier paper Dr. Foerste stated that

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[1] *Ind. Dept. Geol. and Nat. Res., Twenty-fourth Ann. Rept.* (1900), pp. 44, 80.

[2] *Ibid.*, p. 80.

[3] Geol. Surv. Canada, *Rept. Prog. from Commencement to 1863*, 1863, pp. 312–21; and also see Atlas, *Geol. Map of Canada*, 1864.

[4] BRUMELL, *ibid., Ann. Rept.*, N. S., Vol. V, Part II (1892), pp. 52 ff.

[5] LANE, *Geol. Surv. Mich.*, Vol. V, Part II (1895), p. 30 and plates.

[6] ORTON, *Rept. Geol. Surv. Ohio*, Vol. VI (1888), pp. 11 ff., as well as in later reports of the Ohio Survey.

[7] *Geol. Surv. Mich.*, Vol. V, Part II, p. 30.

[8] Ind. Dept. Geol. and Nat. Res., *Twenty-fourth Ann. Rept.* (1900), p. 68.

> The Clinton formation of Ohio is the lowest formation in that state, belonging without question to the Upper Silurian. Between the Clinton of Ohio and the upper fossiliferous beds of the Cincinnati formation occur in many parts of the state a series of unfossiliferous beds which it is difficult to assign definitely either to the Upper or to the Lower Silurian.[1]

The fossils of the Belfast bed, as reported by Dr. Foerste, are *Halysites catenulatus*—a Clinton and Niagara coral not known in the Cincinnatian series of Ohio, Indiana, or Kentucky; annelid teeth, which are identical specifically with forms found in undoubted Lower Silurian limestones; and an *Orthis* allied to *O. calligramma* of the Clinton.[2]

27. By some geologists this system is called the "Ordovician," a name introduced by Lapworth in 1879 for the Lower Silurian of Murchison, which Sedgwick called "Upper Cambrian." This usage, however, is strenuously opposed by the distinguished British geologist, and former director-general of the Geological Survey of Great Britain and Ireland, Sir Archibald Geikie, who has written as follows:

> I consider that this proposal, which was honestly intended to obviate confusion and to promote the progress of the science, is fair to neither of these fathers of English geology, and is especially unjust to Murchison. The division of "Lower Silurian" has the claim, not only of priority, but of having been established and of having had its component members defined by the author of the Silurian system in the early years of his investigation.[3]

When "Ordovician" is used in place of "Lower Silurian," then the term "Silurian" is usually applied to the division which Murchison named the "Upper Silurian." A very cogent reason has been presented against this arrangement by Dr. William B. Clark, who states:

> I prefer the use of Lower Silurian to Ordovician, as I do not think the term Silurian of Murchison can with propriety be restricted to the Upper Silurian. If the Upper and Lower Silurian are to be raised to period position, and Ordovician used, I think some other name should be substituted for Silurian.[4]

28. The mottled clays and thin arenaceous limestones which outcrop in southwestern Ohio, and in the Ohio reports have gen-

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[1] *Jour. Cin. Soc. Nat. Hist.*, Vol. XVIII (1896), p. 163.

[2] *Ibid.*, pp. 163, 165.

[3] *Text-Book of Geology*, 3d ed., 1893, p. 738.

[4] JOUR. GEOL., Vol. VI (1898), p. 342.

erally been termed the "Medina shales"—the lowest formation of the Upper Silurian in western New York—apparently belong in the upper part of the Lower Silurian. Dr. Foreste has studied these beds quite carefully and reports in them several species of fossils, which are of Lower Silurian age. He states:

> It should be remembered that the identification of the Medina in Ohio has not only been solely lithological, but has been practically made upon the sole basis of color. Had the clays near the top of the Lower Silurian not had a single touch of red, or purple color, it is probable that the name Medina would never have been applied to them.[1]

While later in the same article it is stated "the red, purple, and otherwise colored clays below the Belfast bed and its equivalent are, however, Lower Silurian, as is shown by the presence in them of Lower Silurian fossils."[2] The fauna, as reported by Dr. Foerste, is not very extensive, and includes two brachiopods, *Orthis* (*Hebertella*) *occidentalis*, which is not known above the Richmond formation, and "Lower Silurian forms of *Orthis* (*Platystrophia*) *biforata*"[3] (although it must be remembered that this species occurs in the Clinton limestone), "bryozoans of Lower Silurian age," "annelid teeth such as are found in the Lower Silurian," corals as *Tetradium*, and stromatoporoid sponges.[4]

These rocks were named the "Madison beds" by Dr. Foerste in 1897,[5] on account of the typical exposures at Madison, Ind.; but the name was preoccupied as a geological term, for in 1875 Professor Irving named and described the Madison sandstone of Wisconsin. If this formation be a synonym for the "Jordan sandstone," which was named and described by Professor N. H. Winchell in 1874, then the name "Madison" is still preoccupied, for it was applied by Dr. Peale in 1893 to a Carboniferous formation of Montana. Dr. Foerste in some of his reports has used the name "Cumberland sandstone," which was applied by Shaler in 1877 to the upper part of the Lower Silurian rocks exposed along the Cumberland River in southern Kentucky, as apparently equivalent to the Madison beds; but in a late paper he states that the term Cumberland sandstone includes a much larger series of rocks than the name Madison bed.[1] Finally he gives his opinion "that the major part of the rock designated as the Cumberland sandstone by Professor N. S. Shaler must have been of Lorraine age, and if any part of the Richmond is to be included under this name, this is due rather to accident than to the original intention of the author."[2] In this paper Dr. Foerste recognized that the name Madison was preoccupied and stated:

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[1] Ind. Dept. Geol. and Nat. Res., *Twenty-fourth Ann. Rept.* (1900), pp. 67, 68.

[2] *Ibid.*, p. 68. [3] *Jour. Cin. Soc. Nat. Hist.*, Vol. XVIII (1896), p. 165.

[4] Ind. Dept. Geol. and Nat. Res., *Twenty-fourth Ann. Rept.* (1900), pp. 65, 66.

[5] *Ibid.*, *Twenty-first Ann. Rept.* (1896), pp. 218, 220.

> It is therefore considered desirable to change the name of the beds at the top of the Richmond, hitherto called the Madison beds; the name Saluda bed is therefore introduced, taken from Saluda creek, six miles south of Hanover [Jefferson county], Indiana.[3]

The writer is not certain that this bed in Ohio merits a separation from the Richmond formation, as is indicated by the dotted line on the chart. In fact, Dr. Foerste states that "there is no doubt that in southern Indiana and northern Kentucky the Madison beds are merely the upper unfossiliferous part of the Richmond group,"[4] and in proposing the "Saluda bed" he speaks of the hitherto called "Madison beds" as "at the top of the Richmond."[5]

29. The rocks of southwestern Ohio described in the later volumes of the Ohio reports under the name "Hudson River group or series" are here given as the Richmond and Lorraine formations and Utica shale. Clarke and Schuchert did not use "Hudson River" in their revised classification of the New York series and formations in 1899, stating that

> It is becoming increasingly evident that the great mass of shale in the Mohawk and Hudson River valleys which was designated at an early date by this term [Hudson River beds] is resolvable into horizons extending from the middle Trenton to and including the Lorraine beds. At present it seems unlikely that, when this determination of horizons has been carried through

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[1] *Bull. Geol. Soc. Amer.*, Vol. XII, 1901, p. 436.

[2] *Am. Geol.*, Vol. XXX (December, 1902), p. 368.

[3] *Ibid.*, p. 369.

[4] *Bull. Geol. Soc. Amer.*, Vol. XII (1901), p. 436.

[5] *Am. Geol.*, Vol. XXX (1902), p. 369.

the series, any part will remain to which the original term can be applied by virtue of its distinctive fauna, though it may still serve to designate a facies of the formations mentioned.[1]

Finally, Dr. Ruedeman, after an exhaustive study of the Hudson River beds near Albany, N. Y., has reached the conclusion that

> On account of the fact that the mass of beds hitherto called Hudson River shales and correlated with the Lorraine beds of central New York, is composed of terranes ranging from the Lorraine to the lower Trenton, and on account of the lack of a fully representative fauna and of a complete section of the Lorraine portion of these terranes, it is proposed to drop the term Hudson river shales, for the uppermost part of the Lower Siluric, and the term Hudson river group, for the Utica and Lorraine beds.[2]

Clarke and Schuchert have adopted "Cincinnatian" as the name for the series and period composed of the Utica, Lorraine, and Richmond formations.[3]

This formation was named the "Lebanon beds" by Dr. Orton in 1873;[4] but the name was preoccupied, for Professor Safford in 1851 had applied it to a still older limestone of central Tennessee, using it for the two upper divisions of his Stones River group.[5] For the above reason, Professor N. H. Winchell and Mr. E. O. Ulrich in 1897 renamed it the "Richmond group," on account of the excellent exposures at Richmond, Ind.[6]

30. The Trenton limestone is exposed on the northern bank of the Ohio River in Clermont county, particularly in the vicinity of Point Pleasant and on the southern bank of the river opposite Cincinnati.[7] The paper just cited by Professor John M. Nickles gives an excellent account of the last four formations of the Ohio scale, as admirably exhibited in the vicinity of Cincinnati and at other localities in southwestern Ohio.

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COLUMBUS, O., July 3, 1903.

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[1] *Science*, N. S., Vol. X, p. 877.

[2] *Bull. N. Y. State Mus.*, No. 42, Vol. VIII (1901), p. 568.

[3] *Science*, N. S., Vol. X (1899), p. 876.

[4] *Rept. Geol. Surv. Ohio*, Vol. I, Part I, p. 371.

[5] *Am. Jour. Sci.*, 2d ser., Vol. XII, pp. 353–55.

[6] *Geol. Minn.*, Vol. III, Part II, pp. lxxxix, ciii.

[7] *Jour. Cin. Soc. Nat. Hist.*, Vol. XX (1902), p. 60.